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**4-1 Introduction**

The purpose of this chapter is to provide guidance to designers in the application of best management practices (BMPs). A selection process will be presented as well as some design considerations for the BMPs.

Permanent as well as temporary water quality and quantity controls must be designed and installed for all required projects through the use of BMPs. BMPs are the physical, structural, and/or managerial practices that when used singly or in combination, reduce the downstream quality and quantity impacts of stormwater. The designer should, at each stage of the design, evaluate the potential for stormwater degradation and utilize the design with the least impact.

The most efficient pollution control strategy is to emphasize first prevention then treatment. By preventing pollution from occurring in the first place, the need for treatment can be reduced or, in some cases, eliminated. This approach results in three types of BMPs with different means of accomplishing the goal of improved stormwater discharge:

1. Source control BMPs which prevent pollution. These are designed to keep additional pollution from occurring, and to keep soil from being exposed to excessive runoff.
2. Water quality BMPs which provide pollution treatment. These are designed to assure that there is no increase in the pollution in stormwater leaving the site. The most common quality BMPs used by the Washington State Department of Transportation (WSDOT) include grass filter strips, biofiltration swales, wet ponds, and wet vaults.
3. Water quantity BMPs which offer protection to stream ecosystems from erosion and sedimentation, and reduce the potential of flooding. These are designed to keep the volume of stormwater leaving the site from increasing due to construction of the project. Infiltration ponds, dry ponds, and dry vaults are typical WSDOT water quantity BMPs.

WSDOT must allow passage of all off-site flows; however, no treatment is required for the off-site flow. WSDOT must provide quality and quantity treatment for all stormwater runoff from new projects with 5,000 or more square feet (465 m<sup>2</sup>) of additional impervious surface. The goal is to have no impact to downstream properties resulting from the building of the project.

The designer must consider stormwater treatment for construction and usage. The project should be designed to take advantage of the topography, soils, waterways, and natural vegetation at the site. The designer must plan the project so that construction can take place without excessive sedimentation being produced and without excessive flow leaving the site. Finally, the project must be designed so that the required maintenance can be carried out.

## 4-2 Permanent Stormwater Control Features

Permanent stormwater management features are those that are designed into the project and will remain in place throughout the service life of the project. The designer must make sure that the feature(s) will provide the desired results and be able to be maintained in order to continue functioning as designed.

Permanent stormwater control features should be clearly identified as such on the design plan sheets and on the as-built construction plans that will be retained after the project is completed. This documentation is necessary since after a few years of operation some stormwater BMPs, particularly Constructed Wetlands, often begin to resemble natural wetland sites. While wetland resemblance is desirable since it increases pollutant removal and is visually pleasing, undue problems and costs with future maintenance will result if a stormwater BMP is incorrectly considered a jurisdictional wetland by a regulatory agency. A stormwater BMP is designed, constructed, and maintained for stormwater treatment and is not to be considered a jurisdictional wetland at any time in the future.

### 4-2.1 Stormwater Source Control Best Management Practices

The first consideration in design should be source control. Stormwater source controls are designed to prevent pollutants from entering stormwater by eliminating the source of pollution or by preventing contact of pollutants with rainfall and runoff. Source control BMPs shall be applied to the entire project, both existing and additional areas.

Other than street sweeping, there are almost no permanent source control BMPs that can be regularly used for a roadway. Source control BMPs will be used more commonly during construction and for the permanent portion of non-roadway projects such as rest areas and park and ride lots. The source control BMPs to be used during construction are detailed in Chapter 5. When a project involves the storage or transfer of hazardous materials or any waste products, the designer should refer to Section IV-4 of the *Puget Sound Stormwater Management Manual* for guidance on selecting proper source control BMPs.

### 4-2.2 Stormwater Quality Best Management Practices

Stormwater quality controls are designed to remove pollutants contained in runoff. Quality treatment BMPs utilize a variety of mechanisms to remove pollutants from stormwater including sedimentation, filtration, plant uptake, ion exchange, adsorption, and bacterial decomposition. Water quality BMPs are designed to treat the runoff from a 6-month 24-hour design storm. Studies have shown that a majority of the total runoff volume occurs during storms with a return frequency of six months or less. Therefore, only minimal improvements to water quality are achieved by designing treatment facilities to handle rare storm events, while the cost is greatly increased.

The Department of Ecology has identified two categories of pollutants targeted for runoff quality treatment: conventional pollutants and nutrients. Conventional pollutants are those that are typically associated with particles. These include total suspended solids and heavy metals. Nutrients exist in both suspended and dissolved phases and can be more difficult to remove. Examples are phosphorus and nitrogen. Research conducted on the pollutants found in highway runoff has produced inconsistent results; however, in general most studies indicate that

highway runoff is not a major source of nutrient pollution. WSDOT will treat for conventional pollutants on all projects with 5,000 square feet of additional impervious area. Treatment for nutrients will only be performed on those projects located in areas designated by local jurisdictions or the Department of Ecology as having a need for nutrient removal and having 5,000 square feet of additional impervious area.

Water quality treatment to remove pollutants can best be accomplished before the flow is concentrated. Therefore, a grass filter strip is one of the most efficient as well as cost effective water treatment BMPs. Grass filter strips run parallel to the roadway, and runoff from the roadway flows off of the roadway, across the shoulder and then across the grass filter. The flow then can be conveyed in a ditch or other system.

Biofiltration swales are another effective means of removing conventional pollutants that also have a relatively low cost. A biofiltration swale is generally at least 200 feet (60 m) long in the direction of flow and from 2 to 8 feet (0.6 to 2.4 m) wide. Concentrated flow from the roadway section is directed to the high end of the swale. Swales can be part of the stormwater conveyance system.

Wet ponds provide a majority of their water quality treatment by settling suspended solids. Some additional treatment is provided through biological action of plants and bacteria. Wet ponds have a constant pool (dead storage) volume equal to the volume of runoff from the 6-month 24-hour design storm. Wet ponds can be designed for treatment of conventional pollutants only or conventional pollutants and nutrients. Wet ponds can also be designed to provide water quantity benefits by adding a detention volume (live storage) above the dead storage.

Water quality infiltration ponds typically offer the highest level of pollutant removal. The treatment is achieved through settling, biological action, and filtration. Due to the large space requirements and strict soil requirements, this BMP is not suitable for many project locations; however, it is the preferred method of water quality treatment due to its effectiveness at removing pollutants. For this type of infiltration pond, only the 6-month 24-hour design storm runoff is routed to the pond. All runoff from larger storms is bypassed. The water quality infiltration pond is preceded by a settling basin that removes most of the sediment particles that would otherwise reduce the infiltrative capacity of the soil in the infiltration pond.

Ponds, biofiltration swales, and filter strips can visually enhance an area, as well as provide water quality benefits. Swales and filter strips need to be designed for good grass growth. Ponds are more attractive, and appear more natural, if they are not rectangles. The pond may be designed using a rectangular shape to make the calculations simpler, but then be slightly altered to become more aesthetically pleasing.

Wet vaults are commonly used for projects that have limited space and thus cannot provide a location for a biofiltration swale or a pond. They have a dead storage volume equal to the 6-month 24-hour design storm. While wet vaults are appealing due to the minimal right of way requirements, they do not offer as much water quality treatment as other BMPs because sedimentation is the only mechanism cleaning the water. In addition to their reduced pollutant removal, wet vaults create maintenance problems resulting from poor access to perform the necessary

maintenance and reduced ability to determine when maintenance should be done. Typically the increased construction and maintenance expenses offset any initial cost benefits derived from smaller right of way purchases. As a result, wet vaults are the least preferred method of water quality treatment. In many projects where wet vaults are proposed, a better form of treatment could have been utilized if stormwater considerations had been taken into account earlier in the design phase. To ensure that wet vaults are only used when absolutely necessary, the use of a wet vault must receive prior approval from the Hydraulics Section.

#### **4-2.3 Stormwater Quantity Best Management Practices**

Stormwater quantity BMPs are designed to prevent an increase in the amount of runoff leaving a site after development. Increased flows can cause downstream damage due to flooding as well as degrading water quality because of channel and streambank erosion.

Controlling the quantity of stormwater through the use of detention facilities can provide benefits including: reduction of runoff rate increases caused by urban development; mitigation of downstream drainage capacity problems; recharge of ground water resources; and reduction or elimination of the need for downstream outfall improvements.

Detention of stormwater can also have water quality benefits including: decreased downstream channel erosion; control of sediment deposition; and improved water quality through stormwater filtration.

The best method of providing stormwater quantity control is with a pond. There are two types of ponds that will accomplish this. The first type of pond is an infiltration pond. All of the stormwater from a basin flows into the pond and then infiltrates into the ground. The other type of pond is a dry pond, they are sometimes called detention ponds. Dry ponds store the stormwater that runs into them and release flows in accordance with Minimum Requirement 5. When applicable the infiltration pond is preferred since it not only reduces potential flooding but also recharges the local ground water table. However, dry ponds are a very good method of controlling water quantity and will be the most widely used of the water quantity BMPs.

Another method of providing stormwater quantity control is with a dry vault. Dry vaults are commonly used for projects that have limited space and thus cannot provide a location for a pond. They store the stormwater that drains into them and release flows in accordance with Minimum Requirement 5. While dry vaults are appealing, due to the minimal right of way requirements, they do not function as well as ponds. Dry vaults create maintenance problems resulting from poor access to perform the necessary maintenance and reduced ability to determine when maintenance should be done. Typically the increased construction and maintenance expenses offset any initial cost benefits derived from smaller right of way purchases. As a result, dry vaults are the least preferred method of water quantity treatment. In many projects where dry vaults are proposed, a better form of treatment could have been utilized if stormwater considerations had been taken into account earlier in the design phase. To ensure that dry vaults are only used when absolutely necessary, the use of a dry vault must receive prior approval from the Hydraulics Section.

#### **4-2.4 Process for Selecting Water Quality and Quantity BMPs**

The designer should follow the instructions in Chapter 3 to calculate the peak release rates and detention volumes needed for each basin on the project. The selection of BMPs begins with an investigation of the need for treatment and existence of additional restrictions. The project, then each subbasin, is evaluated for applicability of dual purpose BMPs. If no dual purpose BMP is selected, the designer selects both a quality and a quantity BMP. Figure 4-1, Best Management Practices for Stormwater Treatment, is provided to record the decision process.

Complete standards and specifications for each BMP are provided in Chapter 8. BMPs with a “T” in the title have had design modifications from the way they are presented in the DOE Stormwater Management Manual for Puget Sound Basin. An “E” in the title of a BMP indicates that it is an experimental BMP. See Section 4-5.2 for more information on experimental BMPs.

##### **4-2.4.1 Project Concerns**

If the project is adding less than 5,000 square feet (465 m<sup>2</sup>) of additional impervious surface, then there is no requirement for stormwater quality or quantity treatment except for temporary erosion and sediment control for earth work. There may be opportunities to improve the water quality by minor changes within the scope of the project. For example, shoulders or ditches could offer increased stormwater quality benefits by being grassed. The designer should evaluate enhancement opportunities as well as looking for obvious concerns in need of repair such as eroding ditches or shoulders.

When designing for sites where the need for additional stormwater control measures has been identified through a basin plan, watershed ranking process under Chapter 400-12 WAC, or through the Growth Management Act, the most restrictive criteria may apply. The Hydraulics Section should be contacted to determine if more restrictive criteria is to be used for the project. If a plan calls for nutrient control for highway runoff, infiltration BMPs should be used for either quality or quantity treatment. If infiltration BMPs are not suitable for the site then a nutrient control wet pond BMP must be used.

##### **4-2.4.2 Basin Concerns**

Each on-site drainage basin must be separately evaluated. If there are minor culvert discharges that combine before reaching a significant stream, it may be possible to combine the basins in order to reduce the number of BMPs required. It is generally preferable to provide stormwater quality treatment before flows are concentrated.

##### **4-2.4.3 Dual Purpose Treatment Best Management Practices**

The designer begins BMP selection by evaluating dual purpose treatments. These treatment BMPs provide both water quality and quantity treatments in one facility. Therefore, they are often less expensive to construct and have reduced maintenance costs when compared to two separate facilities.

Enter YES (Y) or NO (N) for each question until treatments to meet all requirements are identified. If N, go on to the next question. For each Y use the BMP listed or contact the support group listed. Continue until all required treatment is provided.

Project Wide	BMP/Contact	Y/N
Does project include earthwork?	TESC if Y	
Less than 5,000 sf of impervious added?	End if Y	
Additional Requirements from area plans?	Hydraulics	
Is nutrient removal required?	Hydraulics	

Answer each question for each on-site basin.

	BMP/Contact	Basin					
Dual Purpose Treatment							
1. Regional treatment facility available?	Hydraulics						
2. Will a wet pond with detention fit the site?	BMP RD.05/RD.06						

Any untreated stormwater runoff must have both a quality and a quantity treatment BMP.

Quality Treatment							
1. Will an infiltration pond fit the site?	BMP RI.05						
2. Will a wet pond fit the site?	BMP RD.05/RD.06						
3. Will a filter strip fit on site?	BMP RB.10T						
4. Will a biofiltration swale fit on site?	BMP RB.05						
5. Possible to purchase more right of way?	Proj. Eng.						
6. Will a wet vault fit on site?	BMP RD.15						
7. No practicable quality treatment?	Hydraulics						

Quantity Treatment							
1. Drains to marine water, lake, large river?	Hydraulics						
2. Will an infiltration pond fit on site?	BMP RI.06						
3. Will a dry pond fit on site?	BMP RD.11						
4. Possible to purchase more right of way?	Proj. Eng.						
5. Will a detention vault fit on site?	BMP RD.20						
6. No practicable detention?	Hydraulics						

## Best Management Practices for Stormwater Treatment

Figure 4-1

The designer evaluates each basin by answering a series of questions, in the given order, until the required level of treatment has been met by the selected BMPs. This process will help in the selection of the most effective BMP(s) for the site, both in terms of cost and efficiency. Sound engineering principles should always apply. The questions are as follows.

***Is there a regional detention pond or water quality treatment facility available?***

Stormwater treatment is very effective when done on a regional basis. Instead of creating a large number of small facilities spread throughout the drainage basin which all need to be designed, constructed, and maintained, one large facility is used to provide treatment for all of the basin. Because the design is done by engineers that specialize in stormwater treatment and are familiar with the local area, the overall treatment is usually better. Because only one facility is being constructed, the total construction cost is less than that of the combined costs of the smaller ponds. Because there is only one facility to maintain, the maintenance is performed on a more regular basis and at a lower total cost than for several facilities.

The option of routing stormwater runoff to a regional facility is often not available for a couple of reasons. For a regional pond to exist, the local agency must have done a detailed study of the drainage basin and designed a facility based on the study. Also the facility must have been designed to treat the additional flow from the new WSDOT project. However, if these two cases exist then an effective method of stormwater treatment would be to route the runoff to the regional facility. Typically the local agency will charge a fee to connect to the facility, but this should always be less than constructing an onsite facility.

***Summary of Design Guidelines***

Determine if the regional facility meets all the water quality and quantity treatment requirements and if it was designed to include treatment of the runoff from this project. The conveyance system to the facility must have capacity for the full flow that will be passed.

***Can a wet pond, including both dead storage and live storage be designed to fit site?***

If a wet pond with detention storage can fit within the project limits, the designers should evaluate BMP RD.05.

***Summary of Design Guidelines for RD.05***

- Dead storage, below the outlet, is equal to the volume of the runoff from the 6-month 24-hour design storm.
- Live storage is designed to meet Minimum Requirement 5.
- Provide 1 foot (0.3 m) freeboard above the highest design water level.
- Side slopes should be no steeper than 3:1. If portions are steeper, provide provision to keep people and equipment from being endangered by the steep slope, for example, a fence.
- The pond should be at least three times longer than wide; five to one is preferred.

- Design pond with two cells, separated by a berm.
- Provide access for maintenance to reach the control device.
- Provide an emergency overflow weir.
- Total water depth should not exceed 6 feet (2 m).

If no dual purpose treatment BMPs are applicable, the designers must work through the next two Sections (4-2.4.4 and 4-2.4.5) to select first a water quality BMP and then a water quantity BMP.

#### **4-2.4.4 Quality Treatment Best Management Practices**

*Can a water quality infiltration pond be designed to fit the site?*

If so, design an infiltration pond and go to the detention section. (See BMP RI.05.)

*Summary of Design Guidelines for RI.05*

- Infiltration rate of the soil must be between 0.50 and 2.5 inches per hour.
- The pond must infiltrate all runoff from the 6-month storm within 24 hours after the end of precipitation.
- All runoff that exceeds the maximum rate of runoff from the 6-month storm must bypass the infiltration pond.
- A settling basin must precede the pond.
- Provide 1-foot (0.3 m) freeboard above the highest design water level.
- Side slopes should be no steeper than 3:1. If portions are steeper, provide provisions to keep people and equipment from being endangered by the steep slope, for example, a fence.
- Provide an emergency overflow weir.
- Total water depth should not exceed 6 feet (2 m).

*Can a wet pond, with just dead storage, be designed to fit site?*

If so, design a wet pond and go to detention selection. (See BMP RD.05,

*Summary of Design Guidelines for RD.05)*

- Dead storage, below the outlet, is equal to the volume of the runoff from the 6-month design storm.
- Provide 1-foot (0.3 m) freeboard above the highest design water level.
- Side slopes should be no steeper than 3:1. If portions are steeper, provide provision to keep people and equipment from being endangered by the steep slope, for example, a fence.
- The pond should be at least three times longer than wide — five to one is preferred.
- An outlet structure will release at the maximum inflow rate.
- Design pond with two cells separated by a berm.
- Provide access for maintenance to reach the control device.

- Provide an emergency overflow weir.
- Total water depth should not exceed 6 feet (2 m).

***Can a filter strip be designed to fit the site?***

If so, design a filter strip and go to detention selection. (See BMP RB.10T.)

***Summary of Design Guidelines for RB.10T***

- The runoff leaves the roadway as sheet flow.
- There is 10 feet (3 m) for the grassed filter strip. There will typically be a bare earth zone between the edge of pavement and the start of the filter strip.
- The filter strip slope is 1 to 15 percent.
- The roadway ADT is less than 30,000.
- The road longitudinal slope is not greater than 5 percent.
- No more than two lanes contribute to the filter strip.

***Can a biofiltration swale be designed to fit the site?***

If so, design a biofiltration swale and go to the detention selection. (See BMP RB.05.)

***Summary of Design Guidelines for RB.05***

- The swale will typically be 200 feet (61.0 m) long.
- The maximum width of a swale is 10 feet (3.1 m), parallel swales can be used if a greater width is required.
- The swale must be designed to flow less than 4 inches (100 mm) deep during the peak runoff from the 6-month design storm.
- The swale should be trapezoidal in cross section. Side slopes should be no steeper than 3:1.
- The swale slope is 1 to 5 percent.
- The 100-year developed condition storm must be able to be conveyed through the swale or be bypassed around the swale.
- The flow must enter the swale evenly.

***Can additional right of way be purchased to provide the treatment?***

Seek management guidance on the appropriateness of acquiring additional right of way to provide the required treatment. If additional right of way is acquired, select the BMP to use by returning to the beginning of the selection process.

***Can a wet vault be designed to fit the site?***

If so, design a wet vault and go to the detention selection. (See BMP RD.15.)

***Summary of Design Guidelines for RD.15***

- Dead volume is equal to the volume of the treatment storm.

- Maintenance cleanouts are provided at least every 100 feet (30 m). There must be at least one for each cell of the vault.

***Can it be shown that implementing stormwater BMPs will not be practicable?***

If the project is to be built, seek advice from the Hydraulics Section. The designers should document the process for selection of BMPs, clearly defining why no BMP could be designed to fit the project. A report must be written which describes the effects to the area downstream of the project resulting from not providing any water quality treatment. This report will be included in the Stormwater Site Plan.

#### **4-2.4.5 Quantity Treatment Best Management Practices**

***Does the runoff flow directly to a lake, large river, or marine water?***

If so, provide water quality treatment and evaluate releasing the undetained flow to the receiving body. Consult with the Hydraulics Section when considering this option.

***Does the soil in the area have a infiltration rate of at least 6.0 inches/hour (150 mm/hr)?***

If so, evaluate the use of an infiltration pond. (See BMP RI.06.)

***Summary of Design Guidelines***

- An in-depth soils investigation is required to confirm the following, but the designer can use SCS soil maps to make the first estimate of the appropriateness of this BMP.
- The soil infiltration rate is at least 6.0 inch/hour (150 mm/hr).
- The pond can infiltrate the 10-year storm out of the basin in 24 hours and the 100-year storm in 48 hours.
- There is at least 3 feet (1 m) of soil between the bottom of the pond and the highest ground water level and/or the highest impermeable layer.
- There is at least 20 feet (6 m) to any up slope structure foundation and 100 feet (30 m) to any down slope structure. There is at least 20 feet (6 m) to a Native Growth Protection Easement.
- 1 foot (0.3 m) freeboard must be provided above the highest design water level.
- Side slopes should be no steeper than 3:1. If portions are steeper, provide provisions to keep people and equipment from being endangered by the steep slopes, for example, a fence.
- Provide an emergency overflow weir.
- Total water depth should not exceed 6 feet (2 m).

***Can a dry pond be designed to fit the site?***

If so, design a pond and quality treatment. (See BMP RD.11.)

*Summary of Design Guidelines*

- The pond volume is determined by the method in Chapter 3, and meets Minimum Requirement 5.
- 1 foot (0.3 m) freeboard provided above the highest design water level.
- Side slopes should be no more than 3:1. If portions are steeper, provide provision to keep people and equipment from being endangered by the steep slope, for example, a fence.
- Provide access for maintenance to reach the control device.
- Provide an emergency overflow weir.
- Total water depth should not exceed 6 feet (2 m).

***Can additional right of way be purchased to provide the treatment?***

Seek management guidance on the appropriateness of acquiring additional right of way to provide the required treatment. If additional right of way is acquired, select the BMP to use by returning to the beginning of the selection process.

***Can a dry vault be designed to fit the site?***

If so, design a dry vault and quality treatment. (See BMP RD.20)

*Summary of Design Guidelines*

- Live volume is determined by the method in Chapter 3, and meets Minimum Requirement 5.
- Maintenance cleanouts provided at least every 100 feet (30 m). There must be at least one for each cell of the vault.

***Can it be shown that implementing stormwater BMPs will not be practicable?***

If the project is to be built, seek advice from the Hydraulics Section. The designers should document the process for selection of BMPs, clearly defining why no BMP could be designed to fit the project. A report must be written which describes the effects to the area downstream of the project resulting from not providing any water quantity treatment. This report will be included in the Stormwater Site Plan.

## 4-3 Temporary Erosion and Sediment Controls

The purpose of this section is to provide guidelines and background information that will assist the designer in choosing the most suitable BMPs to control erosion and sediment from projects that involve earthwork. This is done by describing the major problem areas and the appropriate BMPs that could be implemented to manage the problem. Complete standards and specifications for each BMP are provided in Chapter 8.

After designing the permanent erosion controls, the designers must develop BMPs to control sediment and erosion during construction. Construction of roadways can expose large expanses of soil to the eroding effects of water and wind. The first consideration should be to disturb as little of the site for the shortest possible time. Furthermore, the designers must develop the Temporary Erosion and Sediment Control plan to prevent any increase in sediment from leaving the site. The design

should be such that the flow leaving the site during construction is no greater in pollution loading, velocity, or quantity than it was before construction started. All temporary conveyance systems are to be stable during 2-year storm events.

#### **4-3.1 Factors Affecting Erosion Potential**

The inherent erosion potential of any area is determined by four principal factors: soil characteristics, vegetative cover, topography, and climate. A soil with a high silt content will be most easily eroded. By knowing the soil types on the project, the designer can evaluate the severity of the erosion potential.

Vegetative cover plays an important role in controlling erosion because it shields the soil from the impact of rain, holds the soil particles in place, maintains voids in the soil to allow absorbance of water, and physically slows the water. Native vegetation should be left as long as possible and to the extent possible. New vegetation, including temporary seeding, should be provided as soon as possible.

The existing topography should be utilized in the design process. The designer can control the climate only through selection of the season in which land disturbing procedures occur. If clearing and grubbing operations can be conducted during the drier summer months, there is considerable reduction in potential for erosion.

The designer is encouraged to utilize temporary erosion and sedimentation control BMPs as permanent BMPs whenever it is practical. Often ponds used for sediment control during construction can be designed and built as the detention facilities that will be used after the project is constructed. This will eliminate the construction of two separate ponds. If the pond is used for temporary sediment control during construction, the contractor must clean the pond before it becomes a part of the final stormwater management system. Ponds that are designed to include infiltration must not be used as a sedimentation pond during construction since there is no way to clean the trapped particles from within the soil. The sediment laden soil will yield a lower infiltration rate than expected and the pond will not function properly. Additionally, conveyance channels during the construction phase may be able to be utilized as permanent conveyance or even swales, if they are cleaned and seeded as required.

#### **4-3.2 Sediment Retention**

Most projects with earthwork will require at least one BMP to retain sediments on the site. The designers will have to evaluate the following BMPs to determine which is the most applicable to their project.

- E3.10 Filter Fence — This is a very effective BMP that is simple to install.
- E3.15 Straw Bale Barrier — This BMP is used when flows are concentrated.
- E3.20 Brush Barrier — This uses material from the site.
- E3.25 Gravel Filter Berm.
- E3.30 Storm Drain Inlet Protection — This must be used if there are functioning storm drains that could receive runoff from the project.
- E3.35 Sediment Trap.

- E3.40 Temporary Sediment Pond or Basin — This can sometimes be combined with the permanent detention pond.

### **4-3.3 Temporary Cover Practices**

When there is the likelihood that large areas of disturbed soil will be subject to erosion, the designer must consider the need to provide temporary cover. The BMPs to be considered include, in order of priority:

- E1.10 Temporary Seeding of Stripped Areas — This is useful if an area will remain undisturbed for a growing season.
- E1.15 Mulching and Matting — There are a variety of materials available. This method is good for shorter times periods or where future landscaping would be negatively impacted by the grass seeding.
- E1.20 Plastic Covering — This BMP can be effective in controlling sedimentation, but it can result in increased downstream runoff because no water can be absorbed by the ground. This BMP should be used only if the other cover practices can not be used.

### **4-3.4 Structural Erosion Control BMPs**

The designers should evaluate the project for the need for any of the following BMPs:

- E2.10 Stabilized Construction Entrance and Tire Wash — This must be used if there is earthwork and there is an entrance to the site from a paved road.
- E2.15 Construction Road Stabilization.
- E2.20 Dust Control.
- E2.25 Pipe Slope Drains — Consult with the Hydraulics Section if there is a need for this BMP.
- E2.50 Level Spreader — This can also be a permanent BMP in wide biofiltration swales.
- E2.55 Interceptor Dike and Swale.
- E2.60 Check Dams — This can be a permanent BMP in swales to reduce the flow velocity.

## **4-4 Experimental and Other Best Management Practices**

### **4-4.1 Additional DOE BMPs**

There will be projects requiring more extensive BMPs, having requirements not met by the BMPs listed in this manual, or where it is not possible to use BMPs included in this manual. The Hydraulics Section can assist the designer in finding other appropriate BMPs. Additional BMPs are available in the Department of Ecology Stormwater Management Manual for the Puget Sound Basin. These include:

- C2.10 Use of Sandblasting Grits
- E2.30 Subsurface Drains
- E2.40 Gradient Terraces

E2.45	Bioengineered Protection of Very Steep Slopes
E2.70	Outlet Protection
E2.75	Riprap
E2.80	Vegetative Streambank Stabilization
E2.85	Bioengineering Methods of Streambank Stabilization
E2.90	Structural Streambank Stabilization
RI.10	WQ Infiltration Trench
RI.11	SBEC Infiltration Trench
RI.15	Roof Downspout System
RI.20	WQ Porous Pavement
RI.30	WQ Concrete Grid/Modular Pavement
RI.31	SBEC Concrete Grid/Modular Pavement
RF.05	Sand Filtration Basin
RF.10	Sand Filtration Trench
RF.15E	Aquatard System (Experimental)
RD.09	Constructed Wetland
RD.10	Presettling Basin
RO.05	Spill Control (SC) Oil/Water Separator
RO.10	API Oil/Water Separator
RO.15	CPS Oil/Water Separator
RS.05	Vegetative Streambank Stabilization
RS.10	Bioengineering Methods
RS.15	Structural Streambank Stabilization
S1.10	Fueling Stations
S1.20	Vehicle/Equipment Washing and Steam Cleaning
S1.30	Loading and Unloading Liquid Materials
S1.40	Above Ground Tanks for Liquid Storage
S1.50	Container Storage of Liquids, Food Waste, or Dangerous Wastes
S1.60	Outside Storage of Raw Materials, By Products, or Finished Products
S1.70	Outside Manufacturing Activities
S1.80	Emergency Spill Cleanup Plans

#### **4-4.2 Experimental BMPs**

In addition to the BMPs listed in this manual and in the DOE Stormwater Manual, WSDOT can propose experimental BMPs. Experimental best management practices are defined as BMPs which have not been tested and evaluated by the Department of Ecology. Designers are encouraged to propose experimental BMPs whenever they feel that they have developed a BMP which can better perform the required treatment of stormwater runoff than one of the existing BMPs. Most experimental BMPs will likely be variations of an existing BMP, altered to better fit a given project.

The designers must consult with the regional Hydraulics Section when considering an experimental BMP. The Hydraulics Section will provide help in the design and application of the proposed BMP. The regional Hydraulics Section will then work with the Olympia Service Center Hydraulics Section to make the application to the Department of Ecology for an experimental BMP. The request shall include a description of:

- The BMP and how it is intended to function.
- The site or sites at which use of the experimental BMP is being proposed.
- Why the experimental BMP is being requested.
- Applicable construction techniques.
- Sampling and monitoring procedures.

*P3:HRM4*

